**Glow Stick Activity:**

**\*\*This activity involves a lot of dialogue with the instructor. Below is additional background information, and does not need to be shared with students.**

In the following experiment, you'll observe the differences in the brightness of the light given off from a light stick placed in hot water and an identical light stick placed in cold water.

**Materials**

* 3 light sticks of the same size and color
* 2 clear containers (beakers)
* A darkened room
* Ice water (ice from teacher’s lounge)
* Hot water (crock pots)

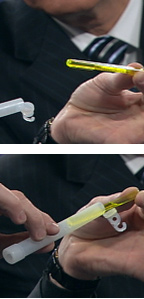
1. In a darkened room, remove one light stick from its package and feel the outside of the light stick to determine its approximate temperature. Bend the light stick until you hear it “snap” and the liquid begins to glow. Shake the light stick to mix the liquid inside. Feel the outside of the light stick again. Has the temperature changed?



1. Fill one of the glass containers with cold water (a mixture of water and ice) and the other with hot water. Ideally you would like to have the hot water around 50 degrees C / 120 degrees F. Be careful not to make the water too hot (above 70 degrees C / 158 degrees F) because it can melt the plastic of the light stick. Never place a light stick in water that is being heated.
2. At the same time, place one light stick in the hot water and place one light stick in the ice water. Leave the third light stick at room temperature. How long does it takes for a change to occur in the hot-water light stick and in the ice-water light stick? What happens to the light intensity or brightness of each light stick?
3. Look closely at the hot-water light stick without removing it from its container. Notice the bubbles rising to the top of the light stick. Compare the rate of bubble formation between the three light sticks. If you have difficulty seeing the bubbles forming, you may have to remove the light sticks from their containers and hold them up to a light source such as a window. What causes the bubbles to form?
4. After a few minutes, reverse the light sticks so that the warm light stick will be placed into the cold water, and the cold light stick into the warm water. How long does it takes for the intensity to change (how long will it take the dim light stick to brighten, and the bright one to dim)?
5. Remove the light sticks from the hot water and the ice water. Allow them to come to room temperature. What happens? How long does it take for you to observe any changes?
6. **Complete the Triboluminescence activity on the last pageif you have time**.

**How does it work?**

When light is produced from a chemical reaction, such as this one, the resulting light is called “chemiluminescence” (say, “chemy-lew-min-ess-cents). The light is said to be “cool” because no heat is produced during the reaction. The reaction between the different chemicals in a light stick causes a substantial release of energy. When the chemicals are mixed, the atoms are excited, causing electrons to rise to a higher energy level and then return to their normal levels. When the electrons return to their normal levels, they release energy as light. This process is called *chemiluminescence*.



The chemical reaction in a light stick usually involves several different steps. A typical commercial light stick holds a hydrogen peroxide solution and a solution containing a phenyl oxalate ester and a fluorescent dye. The chemical compounds are kept separated in the light stick in two chambers. The phenyl oxalate ester and dye solution fill most of the plastic stick. The hydrogen peroxide solution is contained in a small, fragile glass vial in the middle of the stick. The “snapping” or bending action breaks the glass vial and allows the chemicals to mix. The chemicals immediately react to one another, and the atoms begin emitting light. The particular dye used in the chemical solution gives the light a distinctive color. The chemical reaction may last for a few minutes to a few hours to even a few days depending on the formulation. Most light sticks found in the stores will last for a few hours.

As you discovered in this activity, temperature can speed up or slow down the rate of the reaction. If you heat the solutions, the extra energy will accelerate the reaction, and the light stick will glow brighter. However, the light stick will glow for a shorter amount of time. If you place the light stick in cold water, the reaction will slow down, and the light will dim. So, if you want to preserve your light stick for the next day, put it in the freezer. The cold temperature will not stop the reaction, but it will slow down the reaction until you warm up the light stick.

**Luminescence**  
Luminescence is cool (pun intended!). It’s true. Things that are said to “luminesce” usually do so without needing or producing heat. You might think of it as “self-generated” light. This category of glowing stuff is divided into the following even smaller groups: fluorescence, phosphorescence, and bioluminescence.  
  
**Fluorescence**  
This type of luminescence occurs when some form of radiation, such as light, causes an object to glow. For example, fluorescent papers and poster boards glow in the daylight. They may seem to glow even brighter under black light (ultraviolet light), but in either case, as soon as the light is removed, the glow stops. Fluorescent things do not glow in the dark all by themselves – they require some other form of energy such as ultraviolet light to “excite” them.

**Phosphorescence**  
Phosphorescence is just like fluorescence, except that the glow continues even after the light used to excite it is removed. “Glow in the dark” toys phosphoresce brightly in total darkness after being “charged” or excited by ordinary white or ultraviolet light.  
  
**Chemiluminescence**  
Sometimes a chemical reaction can produce light without producing heat. When that happens, we call it chemiluminescence. Light sticks contain chemicals that when mixed produce nearly any color of light.  
  
**Bioluminescence**  
This is a particular kind of chemiluminescence. Fireflies, certain fungi, various fish, and some bacteria can produce light all by themselves. When such living things produce light, it’s called bioluminescence.  
  
**Electroluminescence**  
Perhaps the best example of electroluminescence is lightning. When high voltage electricity passes through a gas, the gas can become excited and glow. In the case of lightning, the electrical spark passes through the air causing it to glow brightly.  
  
Neon signs are also examples of electroluminescence. In this case, high voltages (e.g. 12,000 volts, alternating current) are passed through a glass tube containing neon gas. When the neon gas becomes excited, it produces a bright orange glow. Sometimes argon gas is used instead of neon. The argon produces a blue glow.  
  
Fluorescent tubes, such as those used in overhead light fixtures, use a combination of electroluminescence and phosphorescence to make them work. A white coating called a phosphor covers the inside of the glass tube. The high voltage makes the gas glow which, in turn, excites the phosphor producing pleasant, white, room light.  
  
**Triboluminescence**  
Sometimes light is produced when objects (such as rocks or sugar crystals) are broken, scratched, or pulled apart. This phenomena can be most easily observed when you bite a Wintergreen Lifesavers… in the dark. Try it! Put a Wintergreen Lifesaver (it must be this kind) in your mouth. Turn off the lights and stand in front of a mirror. Bite the Lifesaver and look for the “spark” in your mouth. If you’re lucky enough to break apart one of the Wintergreen favoring crystals, you’ll see a spark.